Ontogenetic habitat shifts by juvenile fishes highlight the importance of permanent river-floodplain connectivity and habitat heterogeneity

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Modified rivers

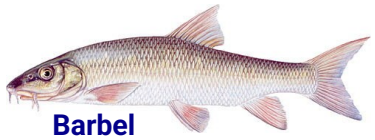
Rivers are the most modified freshwater ecosystems in the world, severely adapted for **flood safety**, **energy production**, **navigation**, and **agricultural land use**

Resulting in

1) Reduced lateral and longitudinal **connectivity**
2) Severe decline in (nursery) habitat **heterogeneity**

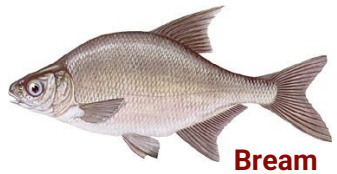
River Waal, Nijmegen, The Netherlands (Photo: Johan Roerink)

Importance of habitat connectivity and heterogeneity



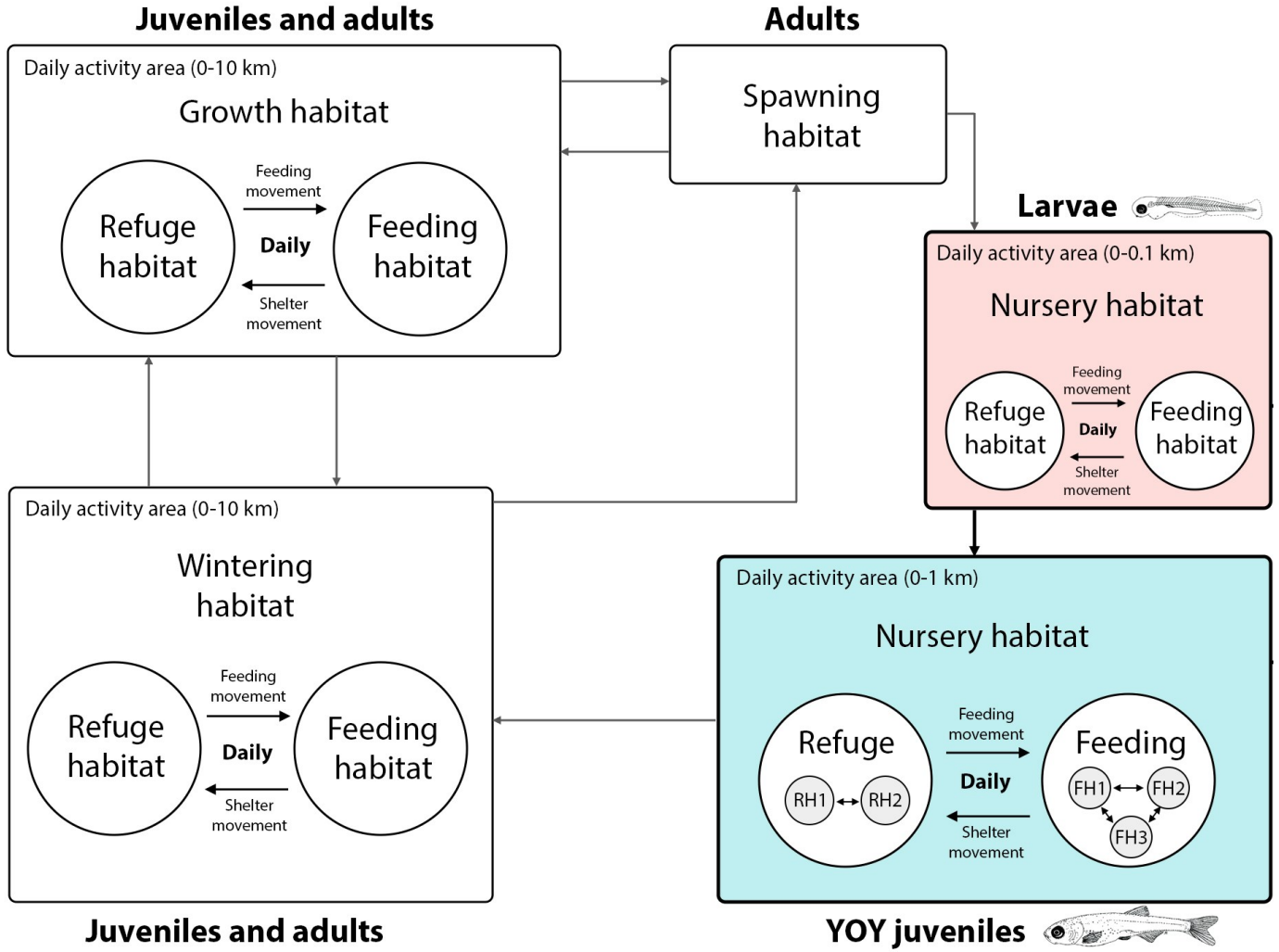
Rheophilics A

Specialists: prefer flowing water throughout life



Eurytopics

Generalists: can thrive in a wide range of habitats



Rheophilics B

Specialists: prefer flowing water in certain life stages

Limnophilics

Specialists: prefer standing water and water plants

Stoffers et al. (2022), *Fish and Fisheries*

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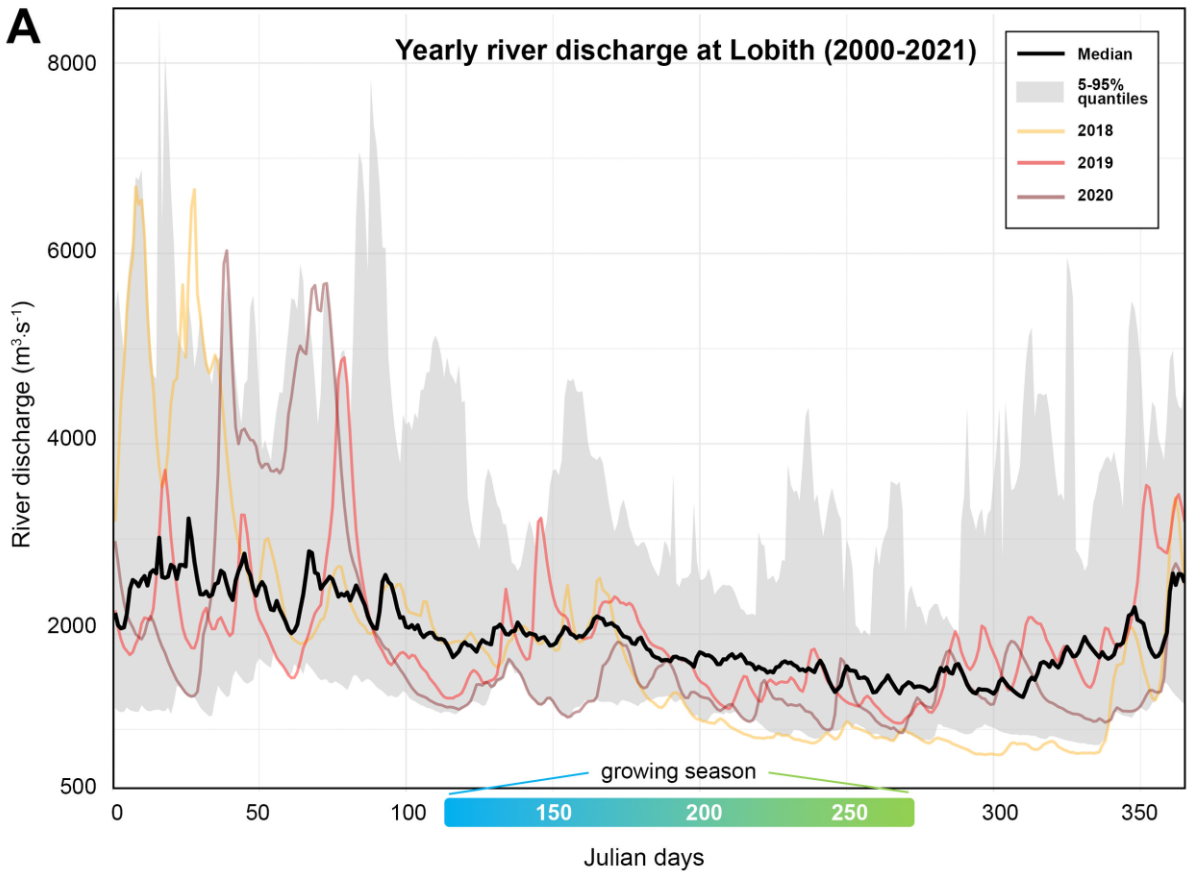
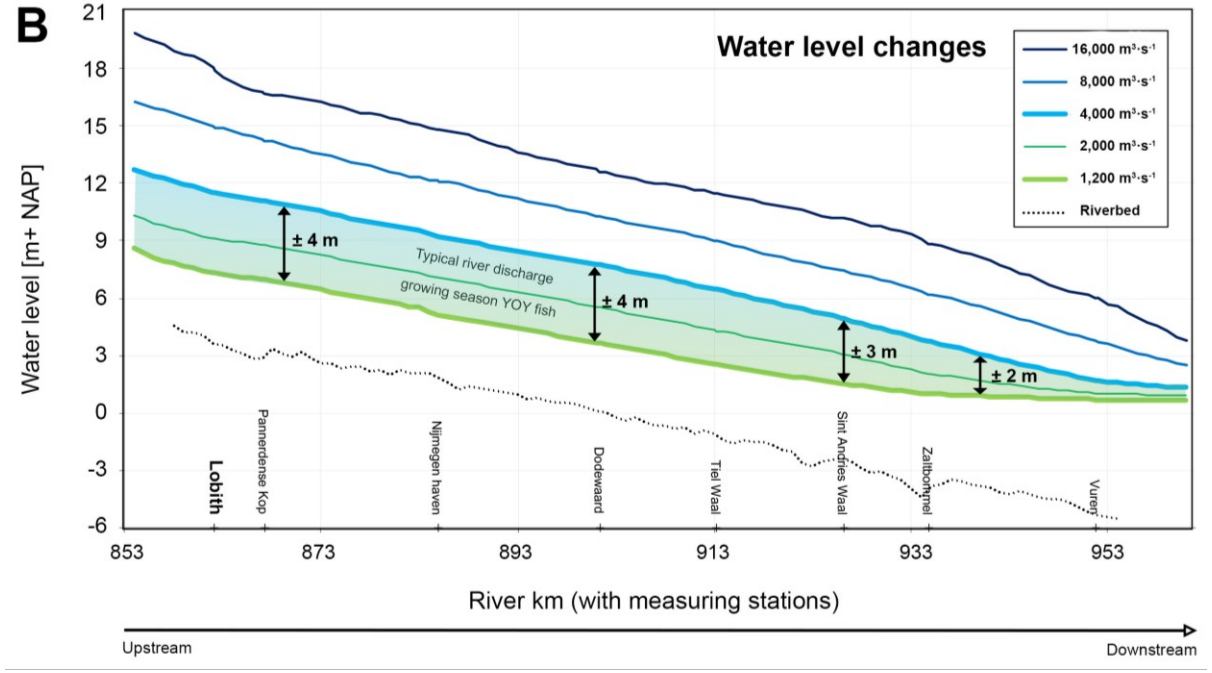
The dynamic lower river Rhine





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Study design

Aim
Assessment of the ecological functioning of river restoration projects as fish nurseries to improve biodiversity

Design
Large-scale evaluation of 46 restoration projects

Period
2017-2020

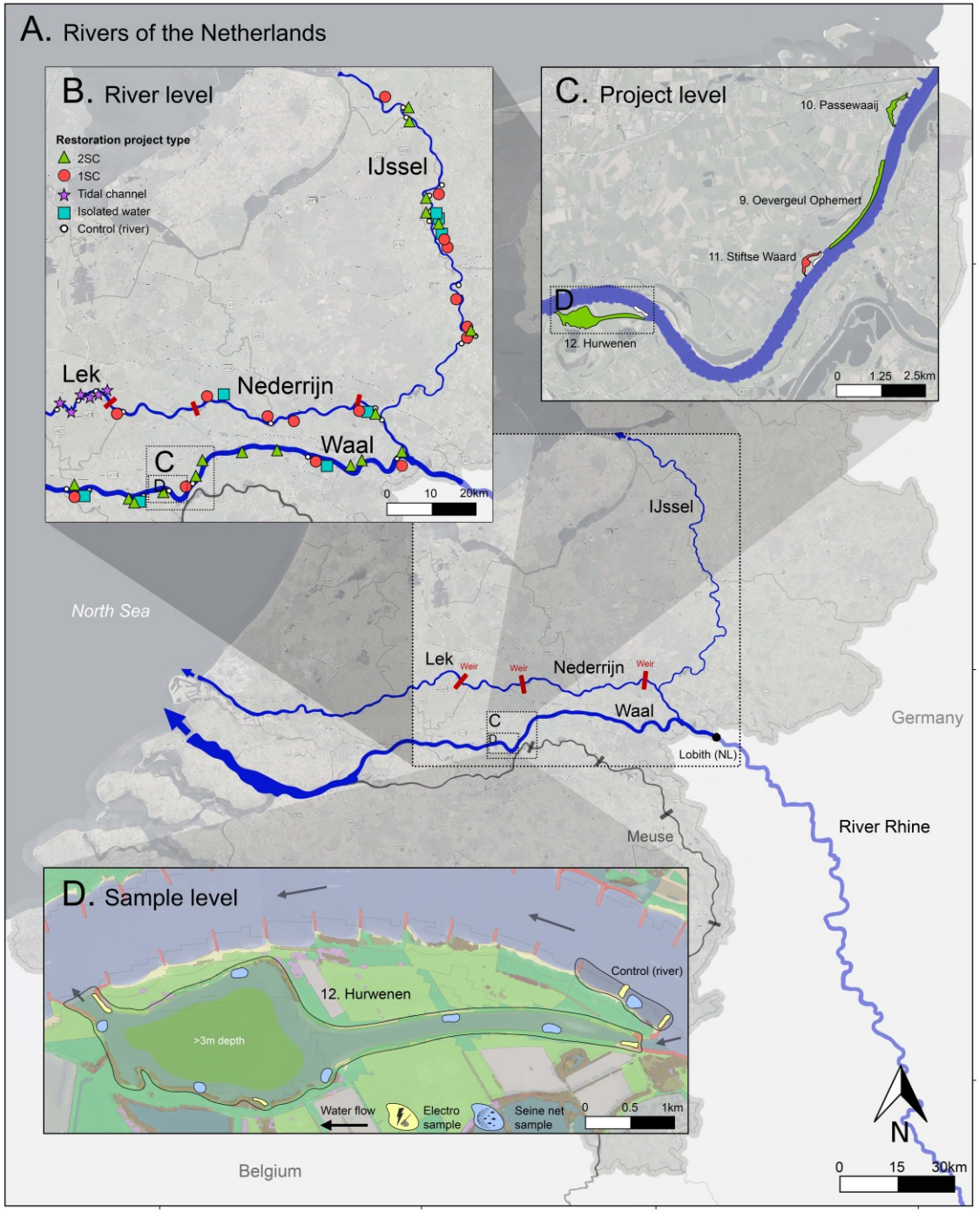
Focus
Habitat heterogeneity, lateral connectivity

Fish community response
Biodiversity and abundances


Eurytopics


Rheophilics


Limnophilics



Stoffers et al. (2022), *Science of the Total Environment*

Fish communities

Stoffels et al. (2022), Science of the Total Environment

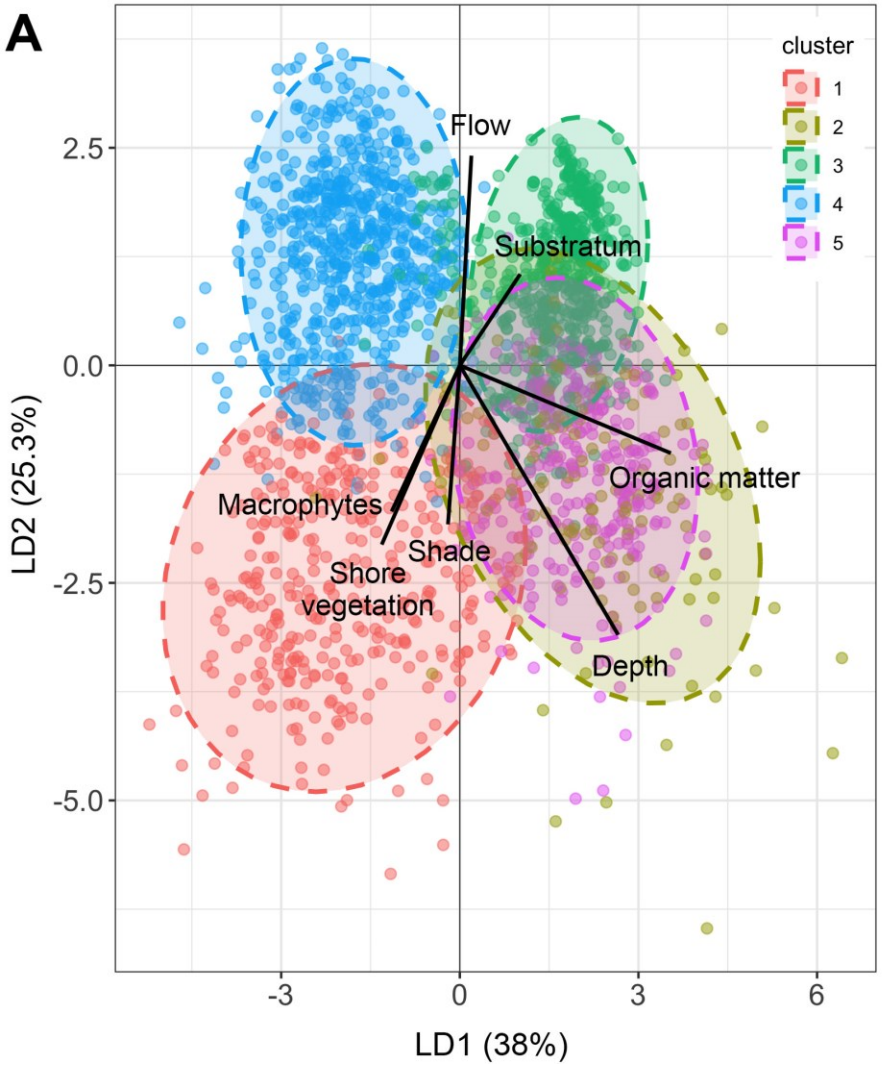
Fish communities

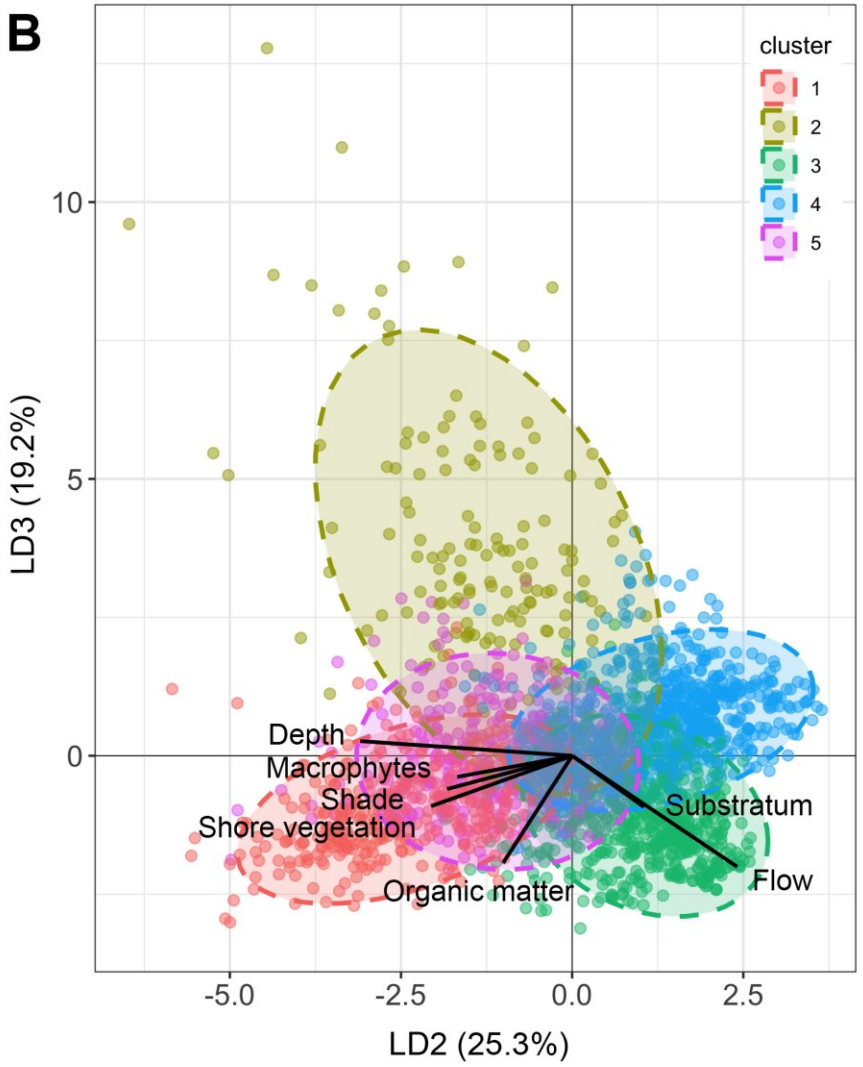
Stoffers et al. (2022), *Science of the Total Environment*

Local habitat

Local habitat

Defining habitat types





15 habitat variables

K-means clustering with Linear Discriminant Analysis (LDA)

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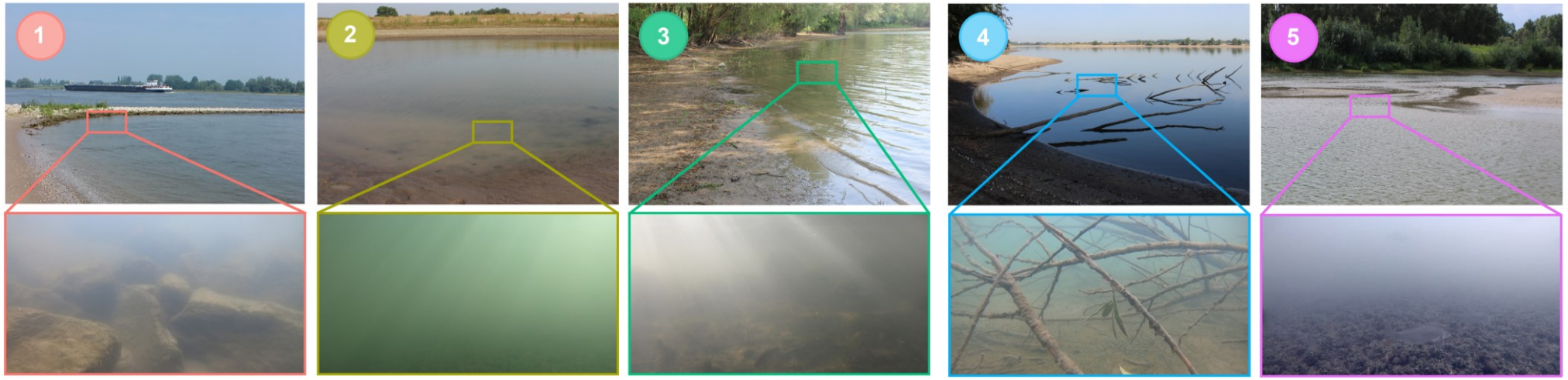
Nursery habitat types in a restoration project

A. Habitat clusters for Hurwenen (2SC)

C. Cluster description

1	Large substratum size, high water flow, bare shoreline, no macrophytes
2	High turbidity and chlorophyll, no water flow, gradual bank slope
3	Small substratum size, shoreline vegetation, macrophytes, shade
4	Deeper water, no to low water flow, woody debris, organic matter
5	Shallow water, low water flow, high oxygen, coarse substratum

B. Habitat photos per cluster



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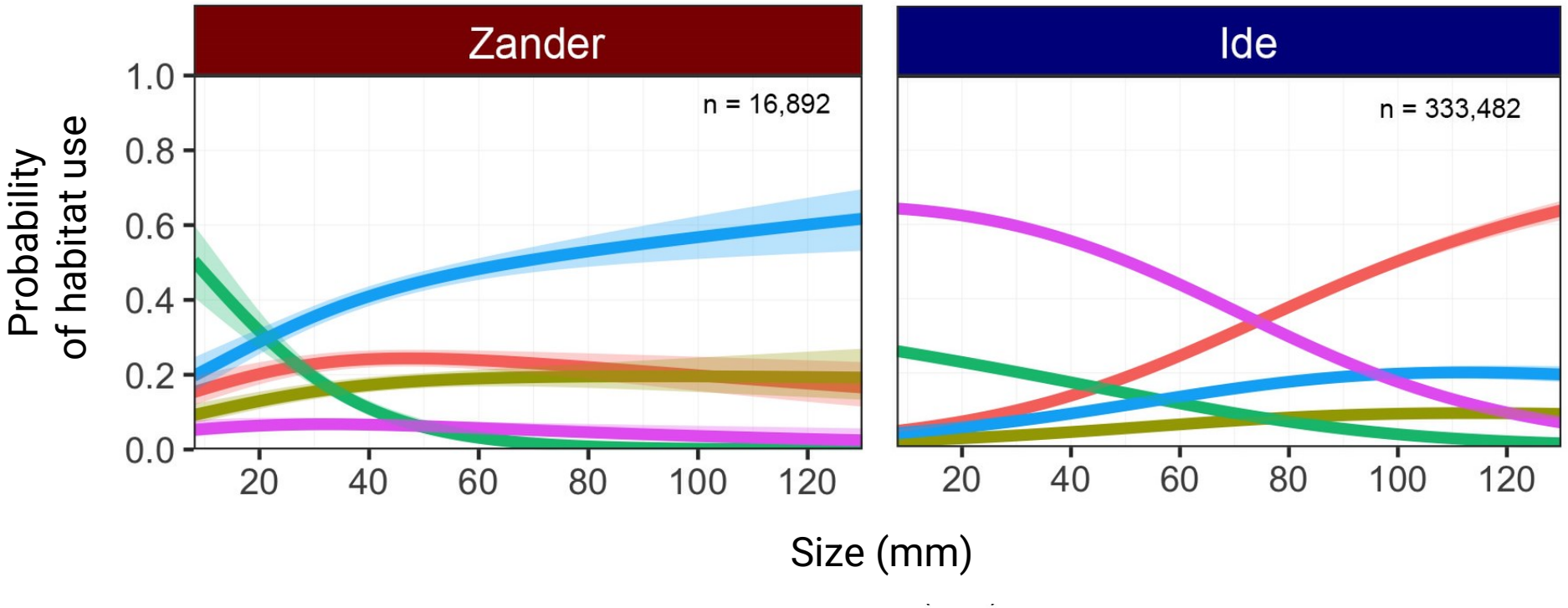
Ontogenetic habitat shift by YOY fishes



Multinomial logistic regression models

Habitat type

	Dynamic fast-flowing	Turbid non-flowing	Shallow sheltered	Deep sheltered	Shallow slow-flowing
	1 Large substratum size High water flow Bare shoreline No macrophytes	2 High turbidity High chlorophyll No water flow Gradual bank slope	3 Small substratum size Shoreline vegetation Macrophytes Shade	4 Deeper water No to low water flow Woody debris Organic matter	5 Shallow water Low water flow High oxygen level Coarse substratum

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Ontogenetic habitat shift by YOY fishes

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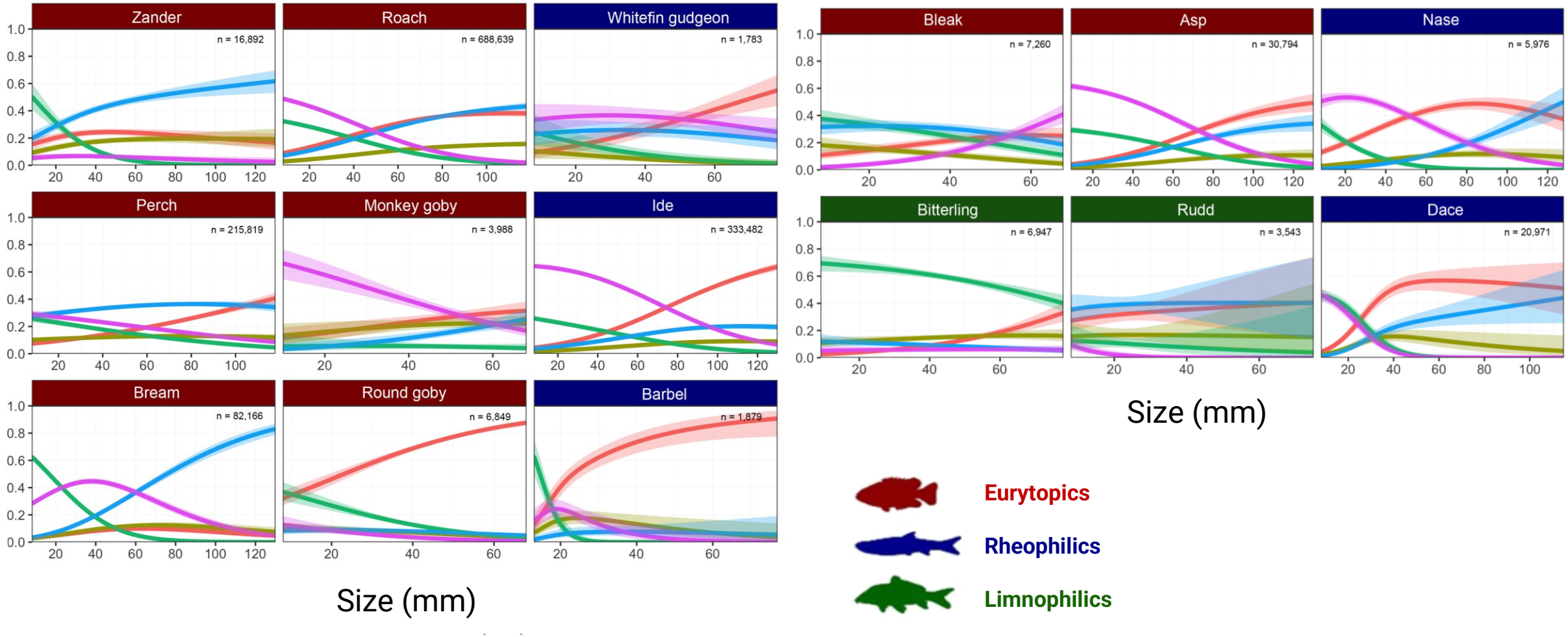

Eurytopics

Rheophilics

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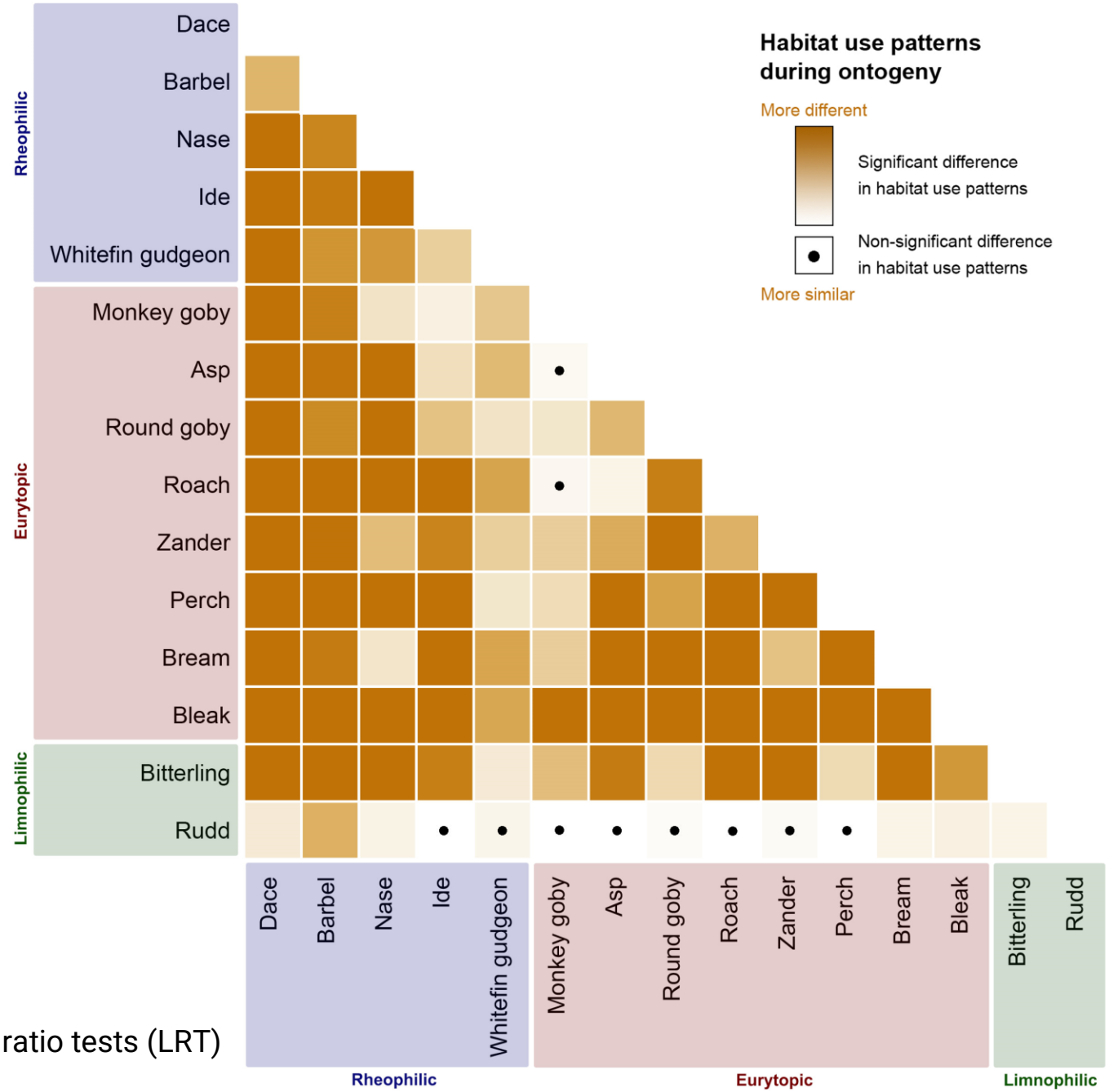
Compare habitat use between species

Ontogenetic habitat shifts throughout the season varied greatly between species

→ **88 out of 98** habitat use comparisons were significantly different



Likelihood ratio tests (LRT)

Concluding remarks

- We highlight the significance of **habitat heterogeneity** in restored floodplains, with ontogenetic shifts in habitat use varying among species, emphasising the need for tailored restoration strategies.

- To increase fish abundances and biodiversity in modified lowland rivers, the following **restoration strategies** are suggested:

1) **Prioritise low-velocity shallow habitats** while also incorporating deeper shelter and fast-flowing dynamic habitats to address the diverse needs of riverine fish species

2) Keep **permanent lateral connectivity** between restored floodplains and main channel

3) Include **deep-water refuges** within floodplain restoration projects, particularly in light of increasing summer discharge variability due to climate change

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Thank you very much for your attention!

If you have any questions, please contact:

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